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General Articles

CONTAGIOUS ABORTION IN EWES.

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The present prosperous condition of sheep farming in this country, as contrasted with the state of depression of the agricultural industry in general, has induced the flock-owner to take a more serious view than formerly of losses due to disease, with the result that he is more anxious to obtain scientific aid in cases of difficulty.

The tendency, which has hitherto obtained, to take little notice of outbreaks may be held to account, in large measure, for the lack of progress in the solution of the many problems associated with sheep diseases, and particularly those of pregnancy. There is reason to believe that contagious abortion is more common than is generally supposed. We have had the opportunity of investigating several such outbreaks during the past two seasons, and have found that they were due to a type of organism different from that previously associated with the disease in this country.

The literature available on the subject is somewhat limited. Outbreaks of abortion both in cattle and sheep have been reported from very early times, but it would appear that definite evidence of

the contagious nature of abortion was not forthcoming until 1889, when the Committee appointed by the Highland and Agricultural Society of Scotland published its report. (1) The Committee succeeded in setting up abortion in ewes and cows by introducing into the vagina cotton-wool plugs soaked in the uterine exudate of aborted animals.

In 1896 Bang (2) attempted to produce abortion in four pregnant ewes by means of cultures of the organism which he had shown to be the cause of the disease in cattle. Although three of these gave birth to living lambs, he was successful in each case in recovering the organism from the placenta.

In 1905 a Departmental Committee (3) was appointed by the Board of Agriculture and Fisheries to inquire into the whole problem of epizoötic abortion. As a result of the work carried out on its behalf by McFadyean and Stockman, considerable progress was made in the study of the disease in sheep. In the first place, these investigators demonstrated by experimental infection that the bacillus of Bang is capable of inducing abortion in pregnant ewes. In studying natural outbreaks of contagious ovine abortion, however, they failed to find the bacillus of Bang, but were able to prove that an organism of an entirely different type, viz. a vibrio, was the cause of the condition. They succeeded in producing abortion in sheep by the administration both of fresh material and of artificial cultures.

In 1919 Carpenter, (4) investigating an outbreak in a flock of sheep in New York State, encountered a condition exactly comparable to that described by McFadyean and Stockman, and isolated a vibrio which was probably identical with theirs.

Without doubt this organism is an important etiological factor in certain outbreaks of abortion among ewes, but, as the Committee point out in their report, it is by no means certain that it is the only one capable of setting up the condition. Indeed, it has recently been reported by certain German workers that epizootics of ovine abortion may be caused by organisms of a different type.

Zeh (5) studied two outbreaks, in which he demonstrated the presence of large numbers of paratyphoid bacilli in the bodies of aborted lambs.

Schermer and Erlich (6) also encountered the condition in two flocks, from which they isolated an organism resembling *Bacillus paratyphosus* (Schottmüller). A few abortions occurred in the second month of gestation, but the majority took place towards the end of pregnancy. The authors prepared a vaccine of the organism which they inoculated into the ewes that had still to lamb. Following its administration the abortions quickly ceased, but, as no controls

were kept, it is not possible to draw any conclusions as to its efficacy.

Outbreaks of a similar nature have been reported by Stephan and Geiger, (7) and by Karsten and Ehrlich. (8) The latter authors resorted to the use of vaccines in an endeavour to prevent further abortions, but here again, unfortunately, no controls were kept.

In a review of the rôle played by organisms of the paratyphoid group in the economy of domesticated animals, Lütje (9) gives a comparison of the types found in the various species, including that described by the foregoing authors as causing abortion in sheep.

In so far as we can ascertain, however, no attempt has been made by these investigators to reproduce the disease by means of cultures of the organism.

History of Recent Outbreaks.

The condition was first brought to our notice in February 1924, in a flock of pedigree Suffolk ewes. Since then we have encountered similar outbreaks in six other flocks.

The first flock was located on a farm which had been in possession of the owner for two years. In 1923 the flock was composed entirely of ewes of his own breeding, and no trouble was experienced, although it was known that outbreaks of abortion had occurred on the farm during the tenure of the previous occupier. The flock for the 1924 season consisted of these same ewes, together with about fifty shearlings bought in the local market, making a total of 208. Abortions commenced about three weeks before the ewes were due to lamb, and continued throughout the lambing period. The number of ewes that aborted was 80, giving a percentage of 38·5. The owner experienced no trouble in another flock composed entirely of ewes of his own breeding kept on a separate farm. It was from this flock that the original ewes on the affected farm were drawn. We were unable to determine whether infection was carried by the freshly purchased ewes, or whether it was contracted on the farm itself. The ewes that had aborted were retained in the flock for the 1925 season, and it is a matter of interest that no abortions have occurred this year, and that a good fall of lambs has resulted.

The other outbreak met with in 1924 was in a flock of 300 ewes, of which 200 lambed prematurely. In this case, also, they were again put to the ram in the autumn and lambed normally the following spring.

This year we have met with five outbreaks in various parts of the Eastern Counties. All have occurred on farms which have been free from abortion for a number of years. In two cases we found that a

XUM

number of ewes had been bought and added to the existing flock since the previous lambing season, but in the other three cases no fresh ewes had been introduced.

The history of the outbreaks has been substantially the same in all the flocks. The abortions may commence as early as six weeks before lambing is due to begin, and may continue throughout the whole season. Some lambs are carried almost to full term, and may even be born alive, though such do not survive many hours.

Signs of approaching abortion are not usually seen for more than twenty-four to thirty-six hours before the act occurs. They consist of some degree of depression and slight stiffness of gait, followed by the appearance of a blood-stained discharge from the vagina. In many cases, however, premonitory symptoms are not observed. After abortion has taken place there is but little tendency to retention of the fœtal membranes. There is a discharge from the uterus, which usually persists for a few days. This leads to a loss of condition which may persist for some time.

If a ewe is killed soon after the act of abortion the following changes are noticed in the uterus. The walls are infiltrated with an œdematous fluid, and are consequently much thicker than normal. The cavity contains a quantity of clear viscid, straw-coloured, odourless fluid. The cotyledons are distinctly swollen and œdematous, and their crypts contain a thick yellowish-white pus which readily exudes under pressure.

A striking feature of an aborted fœtus is the absence of any degree of putrefaction—an indication that expulsion has taken place soon after the opening of the os uteri. Moreover, there is no evidence to lead one to suppose that the fœtus has been dead for any length of time.

A post-mortem examination reveals certain marked changes. When the skin is reflected, the subcutaneous connective tissue throughout the body is found to be infiltrated with a slightly blood-stained gelatinous œdema. The peritoneal cavity contains a large excess of a blood-tinged serous fluid. A similar exudate may be present in the pleural and pericardial cavities. The liver, kidneys, and heart muscle may be œdematous and paler in colour than the normal.

Bacteriology.

Microscopic examination of fresh preparations from the body fluids of the fœtus or the cotyledons shows a large number of actively motile rod-shaped organisms. We have examined a large number of aborted lambs and have readily obtained the organism in pure

culture from the heart blood and all the organs of the body. The same organism has been isolated from the cotyledons and the uterine exudate. Its chief characteristics are as follows :—

A gram-negative bacillus exhibiting a marked degree of pleomorphism. In freshly isolated young cultures it appears as a short oval bacillus. In older cultures, in addition to the foregoing, more definitely rod-shaped forms and even short filaments are seen. Growth takes place on all ordinary media under both aërobic and anaërobic conditions, although it is rather more luxuriant in the presence of oxygen.

On the surface of agar minute transparent colonies may be seen after incubation at 37° C. for fifteen to eighteen hours, and at this stage present the appearance of a culture of streptococci. With further incubation they rapidly increase in size, until by the forty-eighth hour they may have attained a diameter of 3 millimetres, and are rounded, semi-opaque, and slightly raised. In broth a uniform turbidity is first produced, and later there is a tendency to sedimentation. No film develops at the surface. In glucose broth the growth is more abundant, and a few bubbles of gas are produced.

In shake cultures in glucose agar small lenticular colonies develop throughout the medium, which becomes split by the formation of gas. There is no growth on potato. Gelatine is slowly liquefied. No indol is produced. Slight blackening of lead acetate agar occurs. The organism ferments glucose, maltose, lævulose, and mannite, with the formation of a small amount of gas. Slight fermentation of dulcite is noted with some strains after four days' incubation. Lactose, saccharose, salicin, inulin, sorbite, arabinose, inosite, and glycerine are not fermented. There is no change in litmus milk after ten days.

The following table (p. 324) shows the reactions of four strains of this organism isolated from different outbreaks. For the sake of comparison we have included those of certain organisms that appear to be closely related to it, but its exact position can only be determined by cross-agglutination and absorption methods.

Viability and Resistance.

The organism will remain alive in liver broth for a period of at least sixteen months at room temperature without showing any loss of virulence towards mice. It may be assumed, therefore, that under natural circumstances contaminated pasture is infective for a long period. Cultures are not killed by an exposure to 56° C. for thirty minutes nor to 60° C. for fifteen minutes. A temperature of 58° C. for thirty minutes is, however, fatal.

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Strain	Lactose		Glucose		Levulose		Mannite		Saccharose		Dulcite		Inulin		Salacin		Arabinose		Glycerine		Sorbite		Inosite		Maltose		Litmus Milk
	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	
Flock 1	−	−	+	±	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−			+	+	−
Flock 5	−	−	+	+	+	+	+	+	−	−	±	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−
Flock 6	−	−	+	±	+	+	+	±	−	−	±	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−
Flock 7	−	−	+	−	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−					+	+	−
B. paratyphosus ovis (Lütje)	−	−	+	+			+	+			+	+					−	−									Alk
B. paratyphosus—A	−	−	+	+	+	+	+	+	−	−	+	+	−	−	−	−	+	−	±	−	+	+	−	−	+	+	A
B. paratyphosus—B *B. enteritidis* (Gaertner) .. .. *B. suipestifer* ..	−	−	+	+	+	+	+	+	−	−	+	+	−	−	−	−	+	±	−	−	+	+	+	+	+	+	A. Alk

+ = positive. − = negative. ± = slight.
A = acid. Alk = alkaline. A. Alk = first acid, then alkaline.

Serological Reactions.

The agglutination test appears to furnish a reliable method of determining the existence of infection in a flock. The sera of ewes which have aborted agglutinate the organism in dilutions varying from 1 in 50 to 1 in 1,000. It may be noted that in an affected flock some ewes which produce healthy lambs may also show a relatively high agglutinating titre. The sera of normal ewes may give a slight agglutination in a dilution of 1 in 25, but are negative in 1 in 50. The complement fixation test is also of value as a method of diagnosis. In the Appendix will be found tables showing the agglutination reactions of a number of ewes in each flock.

Pathogenicity.

Of small laboratory animals, the mouse appears to be the most susceptible. Intravenous, intraperitoneal, and subcutaneous inoculation of comparatively small doses is fatal in from three to eight days. The minimum lethal dose of a twenty-four-hour broth culture is approximately 0·01 c.c. when injected into the peritoneal cavity or into a vein. On post-mortem examination some degree of emaciation is evident. The spleen is markedly enlarged, very dark in colour, and intensely congested.

Following intraperitoneal inoculation a yellowish-white fibrinous deposit is formed on the liver and mesentery.

Guinea-pigs and rabbits are more refractory. They may succumb to comparatively large doses (1 to 2 c.c.) given intravenously or intraperitoneally, but subcutaneous inoculation leads only to the formation of a large abscess followed by recovery.

Lambs.—On March 15, 1924, a lamb two days' old was inoculated subcutaneously with a twenty-four-hour growth on an agar slant of the organism isolated from Flock 1. Two days later it showed at the seat of inoculation a tender, fluctuating swelling, but otherwise appeared normal. On March 18, 1924, the animal was dull, disinclined to move, and its respirations were somewhat hurried. On the following morning it was unable to stand and showed great depression. In the afternoon it was found in a comatose condition, and was killed by chloroform. On post-mortem examination, a hard, circumscribed swelling of the size of a hazel nut was found at the point of inoculation. The peritoneal cavity contained about 20 c.c. of a clear yellow, serous fluid. There was a diffuse enteritis throughout the length of the small intestine. The spleen was increased in size. There was a slight excess of pericardial fluid. Other organs

appeared normal. The organism was recovered in pure culture from the local lesion, the heart blood, and the spleen.

On April 9, 1925, a lamb was inoculated subcutaneously soon after birth with 2 c.c. of a twenty-four-hour broth culture of the organism isolated from Flock 7. It was found dead on April 14, 1925. The post-mortem findings were similar to those described in the case of the first lamb. The organism was recovered in pure culture.

It may here be mentioned that we have prepared filtrates from cultures grown in many different types of liquid media, but have been unable to demonstrate the presence of any toxic principle.

Experiments on Ewes.

In order to determine whether the outbreaks of abortion were due to the organism which we had isolated, an attempt was made during the first year to induce abortion in pregnant ewes by the administration of fresh material and of artificial cultures. A number of ewes were therefore purchased from a clean farm and were placed on land which was known to have been free of sheep for many years. Five of them, Nos. 14, 22, 25, 64, and 66 were used for this purpose, of which, two, Nos. 14 and 64, aborted. The organism was not recovered, however, either from the aborted lambs or from the fœtal membranes. Full particulars regarding the experiments performed on these ewes will be found in the Appendix.

We were unable to draw any conclusions from these preliminary experiments, since, in the case of the ewes which proved to be pregnant, we doubted whether a sufficient period had elapsed between the time of infection and the act of parturition for the organism to have established itself in the uterus.

During the time that these experiments were in progress the ewes were kept isolated in separate pens away from the rest of the flock. An agglutination test on the whole flock on March 21, 1924, was negative in each case. A re-test carried out on the infected ewes on April 9, 1924, showed that each had developed a high agglutinating titre. A few days later these experimental ewes were mixed with the rest of the flock, and from this time onwards agglutination tests were made at intervals of a few months. These showed that most of the normal ewes had developed an agglutinating titre three months after they had been placed in contact. Subsequent tests indicated a gradual decline in most cases in the agglutinin content, followed by a sharp rise about the time of the next parturition. (See Nos. 21 and 53.) It will thus be seen that the infection, when once established in a flock, is liable to spread rapidly.

At the end of December 1924 a clean ram was bought and placed with the flock, and at the same time four clean ewes were added. It is interesting to note that one of the latter, No. 19, subsequently developed an agglutinating titre.

In March 1925 six ewes, Nos. 15, 17, 24, 60, 61, and 75, whose agglutinating titre had fallen almost to zero, were selected for a feeding experiment. A broth culture of the organism was mixed with their food on the following dates: March 12, March 18, March 25, April 3, and April 10, 1925. Of these, Nos. 24 and 60 aborted dead lambs from which the organism was recovered. No. 75 gave birth to a living lamb at full time, and the organism was recovered from the vaginal discharge. Number 61 lambed normally, and Nos. 15 and 17 proved not to be pregnant. For full details see Appendix.

In the flock for the 1925 lambing season there were twelve ewes which had not been artificially infected but had been in contact with infected ewes since the previous lambing season. Of these, eleven lambed normally, and one aborted dead lambs four days before full time. In the latter case, however, the organism was not recovered. It may be noted that at the time of lambing, three of these ewes showed an agglutinating titre of 1 in 100 or more, six of 1 in 50, and three were negative.

Mention has yet to be made of the results obtained during the 1925 lambing season with the six ewes that were experimentally infected during 1924 (see Appendix). All were again put to the ram in December of that year. No. 14 did not become pregnant. No. 22 died about three weeks before she was due to lamb. The organism was not found in the uterus. No. 66 aborted; the organism was recovered from the uterus and from the organs of the lambs. Nos. 25, 64, and 59 gave birth to normal lambs. No. 59 was killed immediately afterwards and the organism was recovered from the uterus.

The effect of the organism has been tested on pregnant guinea-pigs and rabbits by feeding and injection. The results were negative in guinea-pigs, and in most cases in rabbits. One rabbit, however, which was inoculated with a small dose intraperitoneally aborted, and the organism was present in the uterus and fœtuses. Two others, which were infected by the mouth, gave birth to litters prematurely, but from them it was not possible to recover the organism.

Summary.

In dealing with a disease of this nature, in which the opportunities for investigation are largely confined to the actual lambing seasons, an extended period is necessary for a complete study of the many

problems which arise. We do not therefore feel justified in drawing many definite conclusions from our work in its present stage. We think, however, that it is established that the organism which we have isolated is a cause of abortion amongst ewes on an extensive scale. It was isolated in pure culture from several natural outbreaks, and, moreover, was proved to be capable of producing abortion in pregnant ewes which were artificially infected. Ewes which become infected do not all abort, but a proportion give birth to apparently normal lambs. This has been noticed not only in natural outbreaks but also in our experimental flock. It is possible that the period at which infection occurs may have an important bearing on this point. In this connection the result of our feeding experiment during this year may be borne in mind. The number of animals used was small, but, of the four which proved to be pregnant, two aborted. The remaining two gave birth to living lambs, and in one of them the organism was present in the discharge from the uterus. It would, therefore, appear that the organism is liable to cause abortion in ewes exposed to a heavy infection during the period of gestation. On the other hand, infection which was incurred as a result of contact during the non-pregnant period did not result in abortion during the next pregnancy. This is in agreement with the results noted in Flocks 1 and 2, in which no abortions occurred during the second season, although infection was still being carried by some of the ewes, as evidenced by the presence of a high agglutinating titre. (See Flock 1.) It seems to us reasonable to suppose that such ewes, if introduced into clean flocks, might be the means of spreading the infection.

In conclusion, we wish to express our thanks to our colleagues, Mr. R. L. Cornell, B.Sc., M.R.C.V.S., and Mr. W. L. Stewart, M.R.C.V.S., for the valuable assistance they have given us in the course of this investigation.

APPENDIX.

HISTORY OF EXPERIMENTAL EWES.

A. Ewes Infected in 1924.

Ewe No. 14 when nearing the end of pregnancy was drenched on February 28, 1924, with 5 c.c. of the stomach contents of an aborted lamb (Flock 1) suspended in 20 c.c. of saline. The ewe gave birth to a living, apparently full-time, lamb on March 12, 1924. The lamb died the following day. Cultures from its organs did not show the presence of the abortion bacillus. The ewe was put to the ram in

TABLE SHOWING AGGLUTINATION REACTIONS IN NATURAL OUTBREAKS.

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Flock	Date		Dilutions								
			1/25	1/50	1	2	4	6	8	10	15
		Normal sheep	−	−	−	−					
		Normal sheep	−	−	−	−					
1	28/2/24	Ewe which aborted	++++	++++	++++	+++	+	±	−		
		Ewe which aborted	++++	+++	−	−					
		Ewe which aborted	++++	++++	++	+	±	−			
		Ewe which aborted	+++	++	+	±	−				
		Ewe which lambed normally	++++	++++	++++	++++	++++	+++	++	+	−
	9/5/24	Ewe which aborted	++++	+++	++	±	−				
		Ewe which aborted	+++	++	+	±	−				
		Ewe which lambed normally	+++	++	±	−					
		Lamb	−	−	−	−					
	17/6/25	Ewe which lambed normally	−	−	−	−					
		Ewe which lambed normally	++++	++++	+++	+					
		Ewe which lambed normally	++++	+++	±	−					
		Ewe which lambed normally	+++	+	−	−					
		Lamb	−	−	−	−					
2	9/5/24	Ewe which aborted	++++	++++	+++	+	+	±			
		Ewe which aborted	++++	++++	+++	±	−	−	−		
		Ewe which aborted	+++	++	+	±	−		−		
		Lamb	−	−	−	−					
3	13/2/25	Ewe which aborted	++++	++++	++++	++++	+++	++	±		
		Ewe which aborted	++++	++++	++++	++++	+++	++	++	−	
		Ewe which aborted	++++	++++	++++	++	+	−	−	+	
4	19/2/25	Ewe which aborted	++++	++++	+++	+	−				−
		Ewe which aborted	++++	++++	++++	++++	+++	+	−		
		Ewe which lambed normally	++++	++++	++++	+++	+	±	−		
		Ewe which had not lambed	++++	++++	+++	++	±	−			
5	30/3/25	Ewe which aborted	++++	++++	++++	++++					
		Ewe which aborted	++++	++++	+++	+					
		Ewe which lambed normally	++++	++++	+++	+					
		Ewe which lambed normally	++	±	−	−					
7	7/2/25	Ewe which aborted	++++	++++	+++	+	±	−			
		Ewe which aborted	++++	++++	+++	++	−				
		Ewe which aborted	++++	++++	+++	+++	+++	++	+	−	
		Ewe which aborted	++++	+++	+++	++	±	−			

1/25 = a dilution of 1 in 25.
1/50 = a dilution of 1 in 50.
1 = a dilution of 1 in 100.
2 = a dilution of 1 in 200, etc.

++++ = complete agglutination.
+++ = nearly complete agglutination.
++ = very marked agglutination.

\+ = distinct agglutination.
± = just appreciable agglutination.
− = no agglutination.

December 1924, but failed to conceive. The following table shows the agglutinating titre of the serum on the dates specified :—

Date	Dilutions							
	¼	½	1	2	4	6	8	10
21/3/24	−	−	−	−				
9/4/24	++++	++++	++++	++++	+++	+	±	−
16/6/24	++++	+++	++	+	−			
23/10/24	++++	++++	++++	++++	++	+	±	−
12/6/25	++++	++++	++++	+++				

* Ewe No. 22, which was believed to be pregnant, was drenched on March 12, 1924, with 20 c.c. of broth culture of the same organism. Unfortunately she proved not to be in lamb. She was again put to the ram in December 1924, but died from fatty infiltration of the liver about three weeks before she was due to lamb. She was found to be pregnant, but the organism was not recovered from the uterus.

Date	Dilutions				
	¼	½	1	2	4
21/3/24	±	−	−	−	
9/4/24	+++	++	+	−	
16/6/24	++++	+++	+	±	−
23/10/24	+++	++	+	±	−
22/1/25	+	±	−	−	
12/3/25	++++	++++	+++	+	−

Ewe No. 25, also believed to be pregnant, was inoculated intravenously on March 12, 1924, with 8 c.c. of the same culture. She also proved not to be in lamb. In an attempt to obtain a hyperimmune serum she received intravenously at intervals between July 14 and September 6, 1924, increasing doses of dead culture. The following season she gave birth to two normal lambs.

Date	Dilutions										
	¼	½	1	2	4	6	8	10	15	20	40
21/3/24	+	±	−	−							
9/4/24	++++	++++	++++	++++	++++	++++	++++	++++	++	+	−
16/6/24	++++	++++	++++	++++	++	+	±	−			
28/8/24	++++	++++	++++	++++	++++	+++	+++	+++	++++	+	−
23/10/24	++++	++++	++++	++++	+++	++	++	+	−	−	
22/1/25	++++	++++	++++	++++	++	++	+	+	−	−	
12/6/25	++++	++++	++++	++++							

Ewe No. 64, approaching the full period of gestation, was inoculated intravenously on March 13, 1924, with 25 c.c. of a broth culture of the organism. Eleven days later she aborted a dead lamb.

Cultures were made from the organs of the lamb, and also from the placenta, but the organism was not recovered. In May of the following year she gave birth to two normal lambs.

Date	Dilutions										
	½	¼	1	2	4	6	8	10	15	20	40
21/3/24	−	−	−	−							
9/4/24	++++	++++	++++	++++	++++	++++	++++	++++	++	++	+
16/6/24	++++	++++	+++	+	−						
23/10/24	++++	+++	++	±	−						
22/1/25	++++	+++	+	±	−						
12/6/25	++++	++++	++++	−	−						

Ewe No. 66 was drenched on March 16, 1924, with 25 c.c. of broth culture of the organism. She lambed normally four days later. The organism was not recovered from the placenta. She was put to the ram in December 1924, and subsequently aborted a dead lamb six days before time. The organism was recovered from the heart-blood and liver of this lamb. Shortly afterwards the ewe developed mastitis and died. The uterus was examined and from it a culture was obtained consisting of the ewe abortion organism and a streptococcus.

Date	Dilutions								
	½	¼	1	2	4	6	8	10	15
21/3/24	−	−	−	−					
9/4/24	++++	++++	++++	++++	++++	++++	++	+	−
23/10/24	++++	++++	++++	++++	+++	++	+	−	
22/1/25	++++	++++	++++	++++	++	+	−		
25/5/25	++++	++++	++++	++++					

Ewe No. 59 lambed normally in 1924. In an attempt to obtain an immune serum she received intravenous inoculations of increasing doses of living culture at intervals between July 14, and September 6, 1924. In May 1925 she gave birth to two apparently normal lambs. She was killed immediately afterwards. The uterus and membranes did not show any striking changes to the naked eye, but in both the organism was present in pure culture, though not in great numbers.

Date	Dilutions												
	½	¼	1	2	4	6	8	10	15	20	40	60	80
21/3/24	−	−	−	−									
16/6/24	++++	++++	++++	++++	++++	++	+	±	−	−			
28/8/24	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	+++	+	+
23/10/24	++++	++++	++++	++++	++++	+++	+++	++	++	+	+	−	
22/1/25	++++	++++	++++	++++	++++	+++	++	+	−	−			
27/5/25	++++	++++	++++	++++									

B. Variation in Agglutination Reaction of Ewes Placed in Contact with Infected Animals.

Ewe No. 21. Placed in contact with infected ewes from the middle of April 1924. Put to the ram in December 1924. Lambed normally in 1925.

Date	Dilutions			
	¼	½	1	2
21/3/24	−	−	−	−
16/6/24	++++	+++	+	±
23/10/24	+++	++	+	±
22/1/25	++	+	±	−
12/6/25	++++	++++	++	−

Ewe No. 53. The history of this animal was in all respects similar to that of Ewe 21.

Date	Dilutions			
	¼	½	1	2
21/3/24	−	−	−	−
16/6/24	+++	+	−	−
23/10/24	++++	++	+	±
22/1/25	++	+	±	−
12/6/25	++++	++++	++	+

Ewe No. 19. Put to the ram for the first time at the end of December 1924, and from then onwards was in contact with infected ewes. Gave birth to a normal lamb at full time.

Date	Dilutions			
	¼	½	1	2
23/10/24	−	−	−	−
22/1/25	++	±	−	−
12/3/25	++	±	−	−
12/6/25	+++	+++	++	−

C. Animals Used for Feeding Experiment, 1925.

Ewe No. 17. Put to the ram for the first time in December 1924, and from then onwards was in contact with infected ewes. On March 12, 1925, she was fed along with Nos. 24, 60, 61, and 75 with broth culture of the organism given in the food. This procedure was repeated on March 18, March 25, April 4, and April 10, 1925.

She proved not to be pregnant. As a result of the administration of the organism it will be seen that the agglutinating titre of her serum rose rapidly.

Date	Dilutions			
	½	¼	1	2
16/6/24	−	−	−	−
23/10/24	−	−	−	−
22/1/25	−	−	−	−
12/3/25	±	−	−	−
12/6/25	++++	++++	++++	++++

Ewe No. 24 lambed normally in 1924. In contact with infected ewes from the middle of April. Put to the ram in December 1924. She was afterwards fed with culture. (See Ewe 17.) Aborted two lambs a month before full time. She was killed immediately afterwards and examined. A large excess of a clear straw-coloured fluid was found in the peritoneal cavity. The uterine walls were thickened to about three times the normal. They were markedly œdematous. The uterine cavity contained a clear, pale yellow, odourless, viscid fluid. Pressure on the cotyledons revealed the presence of a thick, yellowish-white pus. The organism was recovered from the cotyledons and the spleen of the ewe. It was not found in the heart-blood of the lambs.

Date	Dilutions						
	½	¼	1	2	4	6	10
21/3/24	±	−	−	−			
16/6/24	±	−	−	−			
23/10/24	+	±	−	−			
22/1/25	±	−	−	−			
22/4/25	++++	++++	++++	++++	+++	+	±

Ewe No. 60. The history of this animal is similar in all respects to that of No. 24. She gave birth to two dead lambs four days before time. The organism was recovered from the placenta and from the organs of the lambs.

Date	Dilutions			
	½	¼	1	2
23/10/24	+	±	−	−
22/1/25	+	−	−	−
12/3/25	+	−	−	−
20/5/25	++++	++++	++++	++++

EWE No. 61. Put to the ram for the first time in December 1924, and from then onwards was in contact with infected ewes. She was afterwards fed with culture. (See No. 17.) She gave birth to a living lamb at full time. The uterine discharge was, unfortunately, not examined.

Date	Dilutions			
	¼	½	1	2
16/6/24	+	±	−	−
23/10/24	+	±	−	−
22/1/25	±	−	−	−
12/3/25	+	±	−	−
12/6/25	++++	++++	+++	++

EWE No. 75. The history of this animal is similar in all respects to that of No. 24, except that she gave birth to two living lambs at full time. A swab taken from the vagina yielded a mixed growth from which the abortion organism was isolated.

Date	Dilutions			
	¼	½	1	2
21/3/24	−	−	−	−
16/6/24	+	±	−	−
23/10/24	++	+	+	−
22/1/25	++	+	−	−
12/3/25	++	±	−	−
12/6/25	+++	++++	++++	++

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THE VETERINARY HISTORY OF THE ISLAND OF HAWAII.

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ISOLATED islands, singly or in groups, have long been recognised as fortunate hunting-grounds for the biologist because there many problems can be studied intensively in clearer detail than in the foggier atmosphere of mainland continents where the threads of life are too closely entangled and complicated. Equally, also, we find a field for profitable study of those pathogenic processes which govern the origin and distribution of animal diseases. The Hawaiian archipelago, by reason of its geographical isolation, its varied climate, the brief time which has elapsed since domesticated animals were introduced upon its virgin soils, and its economic relationship with the western mainland of North America, admirably illustrates these opportunities. It is regrettable that there has so far been very little reliable research work conducted by competent bacteriologists and parasitologists, but it is to be hoped that this deficiency will be repaired before inestimable damage is suffered by the livestock industries of these islands.

The Hawaiian Islands are situated in the North Pacific Ocean about 2,000 miles from the western coast of the United States. The climate is semi-tropical, mild, and winterless, and at sea-level the temperature variation is very slight, averaging about 73° at midday in winter and 83° in summer. At elevations over 6,000 feet occasional frost is felt during winter months. The general characteristic of windward coasts is that of humidity, and of leeward coasts aridity, but there is considerable variance between each extreme. The largest island, Hawaii, has an area of 4,015 square miles, and an animal population of 78,740 cattle, 6,470 horses, 3,985 mules, 2,700 swine, 10,485 sheep, 701 goats, 1,314 dogs, 409 asses. These statistics being taken from tax returns are very incomplete, particularly in the tabulation of asses and smaller animals, and in addition there are large numbers of wild cattle, sheep, pigs, and goats, the latter numbering many thousands. Horses and cattle were introduced into these islands in the beginning of last century, the pioneer animals being brought here by the distinguished British naval explorer, Captain George Vancouver, whose early death deprived the Hawaiian race of a wise adviser and kind friend. The lands devoted to pastoral purposes are those unsuitable for higher forms of agriculture and for forest reservation, vary in depth of soil and fertility, and may be divided into highland and lowland, and wet and dry pastures. Upon the advice of Vancouver a tabu was placed upon the first cattle landed by him; they were set free upon the mountain sides, and being unhindered by human agency, multiplied very rapidly,

inflicting great damage upon the forest cover of the watersheds, to the final detriment of the fertile lower agricultural lands.

In the beginning agricultural development was slow and uncertain, but the removal of tariff duties upon Hawaiian sugar by the Government of the United States in 1876 encouraged an expansion of the sugar industry which has continued steadily, and brought great prosperity to the inhabitants of the whole group. To meet the demands of this industry and the increasing human population, there have been large annual deportations of saddle and draft horses, mules, beef, and dairying cattle, sheep, and swine, and the great bulk of these animals have been shipped through the mainland port of San Francisco. It may be remarked at this point that there are no indigenous animal diseases, and that all the forms of contagious disease are extensions from the American continent.

The first animal disease which compelled notice was equine glanders, and its ravages in and around Honolulu forced King Kalakau and his Government to send to the United States for an expert adviser. This request was responded to by Dr. James Brodie, who came to the islands in 1884, and who was thus the pioneer representative of the veterinary profession. Ten years later we note the embryonic beginnings of an administrative system of veterinary sanitation. There is one Government veterinarian, upon a part-time basis, with a meagre salary and undefined duties, and who gives about the return that might be expected under these circumstances; and boards of livestock inspectors at ports of entry, composed, outside of Honolulu, entirely of laymen who merely draw down fees and do nothing else. After annexation of the islands to the United States was completed in 1900 there was a very decided forward advance. The 1905 Territorial Legislature conferred upon the then recently instituted Board of Agriculture and Forestry powers to add to its existing divisions one relating to animal industry, to employ a superintendent of the same, and to issue rules and regulations governing the importation, inspection, and quarantine of animals, the investigation and suppression of internal disease, and other incidental powers. This was followed by the appointment of Victor A. Norgaard, a Copenhagen graduate, previously in the employment of the United States Bureau of Animal Industry, who proved himself a capable and enlightened administrator. In succeeding years the personnel of the division was increased, and its supervision extended to the other chief islands of the group. In general the laws passed by the Legislature, and the rules and regulations adopted by the Board, have covered very fully and adequately the risks attending importations of livestock, and have been well in advance of current opinion in dealing with the suppression of existing diseases.

The writer landed on the island of Oahu in 1895, and shortly afterwards came to the island of Hawaii, which up to that time had not possessed a resident veterinary service. At that time there were only thirty miles of paved road, which had been opened to traffic the previous year, and saddle horses and pack mules were the sole means of transportation. Now there are two railroads, the greater part of the island is accessible to wheeled vehicles, and the registration of motor cars numbers 4,000.

We will now discuss in the briefest form consistent with adequate explanation a number of the diseases existent upon this island at different times.

The equine diseases which deserve mention are glanders, influenza, cerebro-spinal meningitis, epizootic lymphangitis, tetanus, osteoporosis, parasitic affections, and diseases of the digestive tract.

There is a record of occasional outbreaks of glanders in plantation stables in the earlier period of the sugar industry. At the time of my arrival a remote district in the northern area was heavily infected, and by the year 1898 outbreaks from this source began to be detected around Hilo. In the following years a few outbreaks were caused also by presence of the disease in shipments from California. These outbreaks were a cause of much trouble and serious loss, but the disease was finally stamped out in the southern area by 1913. In the northern area, now separated for purposes of veterinary administration, the saturation of infection was so heavy that the disease persisted until recent date, but is now supposed to be eradicated. Reinfection from the mainland was effectively suppressed after 1908 by requirements of Mallein test certificate and physical inspection before shipment of imported animals, and the additional precaution of a twenty-one-day period of quarantine from date of embarkation. In both this disease and influenza the substitution of mechanical for animal transportation was a potent factor in preventing local spread from place to place.

On the occasion of each outbreak of glanders it was the practice to round up all of the horses and mules in that vicinity and subject them to a careful physical inspection. It was very soon discovered that a large number of native animals, over 50 per cent. in some localities, exhibited a pathological condition closely simulating a very chronic, mild type of this disease. Examination of the nasal septum disclosed discoloration, ulceration, or cicatrix formation upon the visible membrane, usually attended with a scanty, clear, or starch-like, viscous discharge. Always a percentage of these animals reacted to the Mallein test, and many showed nodules in the pulmonary tissue (possibly parasitic ?) upon post-mortem examination. This

condition did not appear to interfere with the general health of the animals, and contact in stables with mules, which are always easily susceptible to glanders infection, was never followed by appearance of that disease. It is, perhaps, significant that V. N. Onissimenko, a Russian pathologist, now engaged in research work on the island of Maui, believes that he has discovered in horses in a district on that island badly infected with glanders many years ago an attenuated type of the *Bacillus mallei*.

Under the heading of influenza are included the various text-book divisions into nasal catarrh, strangles, and the contagious pneumonias, because in every one of our outbreaks all of these types occurred. Our experience suggests that the question of their identity or otherwise is not of practical importance so far as preventive restrictions and sanitation are concerned, because all yield to the same procedure. A delightful, winterless climate is no bar to rapidly spreading, destructive endemics of this form of disease, and in more virulent outbreaks the mortality percentage was comparatively high. In the early days a badly infected cargo of horses and mules would be landed from a sailing vessel upon the beach in Hilo Bay, and immediately distributed to the plantations. In an almost incredibly short time infection would run swiftly all over the island, and there were times when it was almost impossible to get transportation from district to district on account of lack of healthy animals. After each outbreak had passed its apex there would be gradual subsidence for a few years, and then the same process would repeat itself. The precautions adopted to keep out glanders proved to be equally effective in preventing influenza reinfection, although it is impossible to detect the rare and infrequent carrier. For a number of years catarrh and pneumonia have only been seen in the quarantine station, or in animals coming in contact with imported stock, and use of a thermometer in equine practice has become a rare necessity. At this time, when the automobile has displaced the horse on the road, influenza, the most expensive of all horse plagues, is easily controlled by energetic measures of sanitary hygiene. Our own losses were quickly reduced when we learnt the value of early detection by means of the thermometer, strict isolation of infected animals, and thorough periodical disinfection of premises and harness. In all countries where the disease is endemic disinfection of railroad cars and auction stables should be a compulsory routine measure.

Epizootic lymphangitis was debited to Hawaii on the authority of Norgaard, who considered the abnormal appearances on the nasal septum of native horses to be an atypical form of this disease, and it is so included in the geographical distribution passages in many text-

books. The writer has never seen a typical case of epizootic lymphangitis here, although its occasional occurrence on other islands may have been possible.

Tetanus has been more or less common on the other islands for many years, but no cases were seen in this practice until fifteen years ago. Then the appearance of several cases in a few months portended the possibility of serious consequences in the warm, humid climate of the Hilo district. This, however, has not occurred, and the annual toll is not more than ten or a dozen animals. Under a system of quiet isolation and soft feeding without medical treatment, the percentage of recoveries is unexpectedly high.

In the earlier years osteoporosis was the bugbear of practice in the wet districts, and every case of mild lameness had to be carefully examined with the thought of this disease in mind. Its prevalence began to decline after 1904, and our stables have now been free from the disease for many years. This disappearance would seem to be a matter of easy positive accountability, but in truth it is very difficult to construct a sound, reasonable hypothesis to account for it. Certainly its complete elimination appears to refute the theory of bacterial origin advanced in 1899 by myself, because environmental changes have not been of a nature to interrupt the normal cycle of such diseases. In larger stables newer and more sanitary buildings have been erected, there has been a general adoption of a better balanced system of feeding, and the heaviest field work has been transferred to mechanical caterpillars and tractors. Probably, however, the old conditions are to some extent existent in the small stables owned by alien Asiatics, who rarely ask for professional advice, but even there the well-marked symptoms would attract attention in the event of the disease being present. It seems logical to assume that the environmental change responsible for the disappearance of this disease is contained in the improved dietary with its more efficient balance of imported artificial and natural foodstuffs, and this view is supported by one significant episode, namely, the abrupt cessation of osteoporosis in a badly ravaged stable when bran feeding was discontinued, and the proportion of natural forage increased. The relationship between osteoporosis and bran feeding is unmistakable, and this suggests a vitamine deficiency, which added to the known vitamine deficiency in the rank, lush grasses of our wet districts may supply the answer to the problem.

Throughout this period of thirty years epizootic cerebro-spinal meningitis has caused severe losses in various localities, but chiefly upon other islands of the group. It was more common formerly upon Hawaii, and is now seen very occasionally in the dry districts.

For some reason unknown two or three cases are seen every year in one stable belonging to a sugar plantation.

Parasitological research has been neglected, and no attempt has been made to classify the species and varieties of parasites existing here, or to investigate their extent and distribution. Of the larger ectozoa, the gastrophilus is abundant on dry pastures, the ear tick has been reported on young stock, individual invasions of lice are seen rarely, and, because of good sanitation, the stable fly is much less of a nuisance than in most tropical countries. In former days when there was a larger use of pasturage in the wet districts, animals exposed on these heavily infected soils were subject to excessive parasitism usually ending in death, and were literally eaten alive by the masses of tape and round worms in the stomach and bowels. Upon the breeding ranches, which are mostly at higher altitudes, the animals roam in a state of nature, and, although parasitic infestation is common, seem to suffer very little ill effect so long as food and water are plentiful.

Granular dermatitis, or " summer sore," is commonly seen in all of the equine tribe, and every donkey in the wet area is a victim to this intractable affection. A non-contagious acne, called by the Hawaiians " pu-pu," characterised by nodules, vesicles, and pustules, and accompanied by annoying itching, is frequently noticed in stabled animals, and is probably also of parasitic origin.

Older practitioners in Britain whose memory dates back to the 'nineties will recall the harvest of colics, gastro-enteritis, and digestive troubles in the large tramway, railroad, and brewery stables of that time. In the beginning conditions were very little better in Hawaii, but have now been improved to the point of almost complete elimination, and mortality percentage from these diseases is negligible. This fortunate change is due to better methods of feeding, and lessening of exposure to undue fatigue strain. Very beneficial results were always noted in stables where the daily food ration was supplemented by crude molasses, and in one particular stable which furnished cases of these diseases every week in the year the effect of this addition was remarkable.

At one time there were animals in all of the plantation stables which were known as " blowers," because after return from work they stood for hours with food untouched and heaving sides. The " blower " was usually in good condition, had a staring coat in which every hair stood out individually, and never sweated at work. Occasionally such an animal would start to " blow " when at rest in the stable, and keep this up for two or three days. Their most acute and dangerous period was during the months when the winter coat was being acquired,

and it was not unusual for a " blower " working on a hot autumn afternoon to stagger and fall and die from pulmonary congestion. Post-mortem examinations upon long-standing, chronic cases revealed an extensive condition of pulmonary emphysema. Finally, the radical preventive and cure for this trouble was found in the use of the clipping machine, and universal adoption of the practice of periodical clipping has eliminated this source of loss.

It is worth noting as a matter of passing interest that, although the accidents which produce poll-evil, fistulous withers, and quittor are very common and frequent, these surgical conditions are rarely encountered in Hawaiian practice; and also that wounds tend to heal cleanly and quickly, and without dangerous septic infection.

In the earlier years the horse and mule absorbed the whole attention of the veterinarian. Cattle were cheap, the period of improved breeding was in its infancy, and the mild climate and natural mode of life exempted the bovine from most of the varied troubles which beset this species in the more closely populated regions of the temperate zone. Now the situation is reversed, and, with the horse safely protected against the hazards of disease, effort is anxiously devoted in warfare against new and insidious foes which threaten the ruminant.

It is a safe guess that the original stock of cattle was not infected with tuberculosis, and it is most probable that the disease was brought in from time to time in importations of improved dairy stock. A test in 1900 of a pure-bred Jersey herd near Hilo disclosed reactors, and this herd was undoubtedly responsible for extension of the disease through adjacent districts discovered at a later time. The first legal restriction aimed at this disease was promulgated in 1906, and provided that all imported animals must be accompanied by certificates showing that they had passed a tuberculin test prior to shipment. It may be said briefly that our experience indicates that even this is not a sufficient safeguard, and that, no matter what the origin of the cattle may be, a quarantine period and retest are necessary. By these measures a large number of tubercular animals have been prevented from shipment, and others, which have slipped past the first barrier, have been detected after landing. The first systematic test among the dairy cattle on the island of Oahu was made in 1910, and the percentage of reactors, 23·49, was unexpectedly high. An initial test on the island of Hawaii in 1914 eliminated 7·7 per cent. of diseased animals. The subcutaneous test was found impracticable for use under our conditions, and the intrapalpebral form of the intradermal test was finally selected on account of its economy of time and convenience in administration. With this test the inspector

can cover a much wider area, many more animals, and it is applicable to wild, unhandled stock which are unsuitable for other methods. As many as 543 injections have been made by one inspector in a single day, and where the animals are easily accessible in fair-sized units 200–300 injections are well within the capacity of any inspector. In 1917 the Legislature passed a Bill providing that all dairy cattle over six months of age must be tested with tuberculin annually or oftener, reactors branded, quarantined, and slaughtered, premises disinfected, and compensation was formulated on the basis of appraised market value. The owner received salvage plus a contribution from the Government, totalling 100 per cent. of appraised full market value for condemned animals not exhibiting lesions after death, salvage and a contribution making 80 per cent. where lesions were localised and flesh marketable, and a contribution of 50 per cent. if the carcase proved unusable. Under this system the owner's receipts averaged about 80 per cent. of market value, of this salvage accounted for 44 per cent., and the indemnity for 36 per cent. Afterwards a much less equitable system of flat-rate indemnification was substituted with payments of $100 for pure-bred, and $50 for grade cattle, regardless of extent and amount of disease, and $350.00 and $250 respectively for pure-breds and grades without discoverable lesions. As always happens in these campaigns, the abrupt fall in the percentage of reactors in immediately succeeding years encouraged hope that complete eradication was certain and only a matter of a short time, but results prove that there is much merit in Guerin's assertion that it seems impossible to achieve this aim by the procedure of compulsory testing. Last year the percentage of reactors on Oahu was 3·40, and on Hawaii 1·30, and these figures seem under present conditions to be in the neighbourhood of an irreducible minimum. Meanwhile there is to be added the disconcerting revelation arising from the introduction of a stricter and more careful examination in the Honolulu abattoir that lesions are found in over 4 per cent. of beef cattle, and 2 per cent. of swine slaughtered there! The principal obstacle to success was not recognised in the beginning, and is, of course, the non-reacting tuberculous animal which only too often conceals dangerously infective open lesions under cover of a well-padded hide. Probably this obstacle can be overcome, but its conquest is only achievable by comprehensive, persistent, and continuous effort. The campaign must include every animal in each species capable of transmitting infection, testing must be regular and continuous, and the infected herd must be subjected to the most searching tests, or combinations of tests, repeated after the shortest possible intervals. These conditions have not been complied with in

the Hawaiian campaign, where testing has been confined chiefly to dairy cattle, of which there has been every year an untested residue, where there have been intermittent periods of cessation due to lack of funds to provide compensation, and where the exigencies of other duties have not always allowed the official staff to fulfil the essential requirements of vigorous and persistent retesting of infected herds. Nevertheless, even if the ambition of complete eradication has not been realised, the disease has been diminished to manageable proportion, and we are in an immeasurably better position than we would have been if the effort had not been made. The fact of rapid and insidious spread in a climate where cattle spend most of their time in the open air corroborates the belief that the most potent factor in transmission is contamination of food by infective excretions and discharges.

The annual increases in human population created a demand for larger milk production, which was met by heavier investments of capital in the neglected dairy industry. Naturally, thought was directed at once to the question of breeding improved stock, and much money was spent in importation of pure-bred animals from the mainland. The result was disastrous, because, in almost every case, with the pure-bred came the unforeseen and quickly spreading contagious abortion infection. This disease is mentioned for the first time in the official report for 1920, and it is stated now that all of the pure-bred, and many of the grade, herds on the islands of Kauai, Oahu, and Maui harbour infection. Fortunately for the island of Hawaii, the wave of enthusiasm over improved dairying was regarded less seriously, and during that period only a few pure-breds were brought in. At the present time the infection is only known to exist in one isolated herd. No legal restrictions are enforced in connection with this disease, but a requirement that all imported cattle must be accompanied with a certificate that they have been subjected to the agglutination test is contemplated.

If a complacent belief existed that infective animal diseases could be efficiently avoided by application of modern methods of inspection and quarantine, it was badly shattered in 1917, when a series of explosions of a septicæmic type of disease occurred almost simultaneously on each of the four larger islands. We note that in 1916 Norgaard reports that an investigation of the deaths of several cattle occurring in shipment from the Kona district of the island of Hawaii revealed the presence of hæmorrhagic septicæmia. He adds that so far there had been no outbreaks of this disease. It is, however, not improbable that there had been previously unnoticed and unreported deaths of individuals in the large beef herds, where, among their several thousand animals, the loss occasionally of two or three was

not considered of particular significance. The disease appeared in the Kau district of the island of Hawaii in 1917, reappeared in another part of the same district in 1919 with a loss of 160 animals, and since then has been seen each year more or less generally all over the island under varied conditions of altitude, humidity, and soil fertility, and in both beef and dairy cattle. The typical outbreak has consisted of a sudden explosion of disease affecting animals of all ages, a number of fatalities with few recoveries, and then quick subsidence. This year, however, in a pasture in Kau grazing about 1,000 head of stock, and where two typical outbreaks had occurred previously, twenty-five young animals under two years of age died very suddenly, and the cause was demonstrated by Onissimenko, after bacteriological examination of material, to be blackleg or quarter-ill. This accords with his experience upon the island of Maui where for several years the greater mortality has occurred in young stock, even sucklings a few days old falling victims to attack, and where he finds the prevailing infection to be blackleg, although hæmorrhagic septicæmia, the original diagnosis, is present in smaller amount. It is evident that a clinical differentiation between these two diseases is exceedingly difficult, and that much more bacteriological research will be needed to determine their respective proportions. This arises from the fact that the blackleg infection encountered here appears to be very virulent and atypical, attacking animals of all ages, very rapidly fatal, and with absence of the pathognomic external swelling. From the beginning these outbreaks have been combated by injection of commercial immunising material, hæmorrhagic septicæmia bacterine, and, more recently, aggressin, into all in-contacts and other cattle in the neighbourhood. In field work it is very difficult to estimate the value of these prophylactic agents, because, even without treatment, the disease usually disappears as quickly as it came, and favourable results have been reported in cases where it is now known that the actual infection present was not septicæmia, and was blackleg! The origin of these outbreaks offers matter for interesting speculation, but it is not easy to construct a hypothetical cycle of events which accounts for all of the circumstances above described. It seems improbable that the virgin soils of these islands were already infected with these ubiquitous bacteria before cattle arrived here, and more probable that the infection was introduced in the bodies of normally healthy animals. A mild, winterless climate permits continuous grazing, and encourages rapid multiplication of animals, until a point is reached where density of population is greater than the land can carry. Meanwhile two processes are acquiring a steadily increasing momentum: (1) deterioration of soil fertility, and (2) in-

fection of the soil with pathogenic bacteria and parasites. In general these have been the conditions which have obtained over much the larger part of the Hawaiian pastoral lands, and it was inevitable that defiance of the known principles of soil hygiene, particularly of pasture resting, rotation, and treatment, would finally result in disaster due to soil infection.

For many years a peculiar hæmaturia was seen in cattle at elevations between 3,000 and 4,000 feet on the mountain side. It was characterised by anæmia, progressive emaciation, and blood-stained urine, resulting from ulcerative changes in the mucosa of the bladder. The paucity of references in contemporary veterinary literature suggested that possibly this was truly an example of indigenous disease caused by eating indigenous plants, but it is now known that a similar disease exists elsewhere, notably in the north-western Pacific region, where it has been ascribed to excess of oxalic acid in certain herbage.

The *Hypoderma bovis* is found on highland pastures, and the vicious hornfly, the *Hæmatobium serratum*, introduced twenty-seven years ago, exists wherever cattle are grazed. This pernicious blood-sucker settles like a cloud upon the skin of the defenceless bovine, and by its persistent irritation causes serious loss to both beef ranch and dairy. The liver fluke was noticed first in the Hilo district about twenty years ago, and is gradually extending its boundaries and ruining the wet lowland pastures. The œsophagostome, or nodular worm, seems also to be firmly established on wet pastures, and, to some extent, upon the semi-arid lands. Lung worms have only been detected in imported cattle, and it is not yet known whether this has resulted in permanent pasture infection. Although parasitic diseases have not so far emerged into prominence in cattle-breeding operations, it is a safe prediction that, unless proper precautions are taken in time, they will eventually prove a serious menace to the stability of the cattle industries.

The diseases of the smaller animals are not important, and can be dismissed in a few words. Flocks of sheep range on the higher lands of the mountain ranges, many in a wild state, and are said to be very free from disease. The swine breeding industry is a very minor one, principally in the hands of Asiatics, who accept losses as a matter of course, and rarely report them. There is very little traffic in, or movement of, these animals, and an endemic of hog cholera in early years, after causing considerable loss, died out for lack of further fuel. Septicæmia is an occasional destructive visitant under conditions of defective sanitation. Parasitic losses have been noted in connection with Ascaris and Stephanurus infestations. The only

serious ailments of the canine are also due to parasites. Mange is very common among the native dogs; the "heart worm" is detected occasionally; and tapeworms and roundworms are abundant in the alimentary tract of young animals. Distemper is unknown on the island of Hawaii, but is seen on other islands where greater interest in this animal has encouraged importation from other countries.

In conclusion it may be remarked that nowadays mere geographical isolation is an insufficient protection against the introduction of disease unless supplemented by all of the weapons furnished in the armoury of modern science, and that, even when these are employed, there is still a margin of bacterial and parasitic infection that will escape all tests and pass all barriers. In the more tropical zones permanent animal husbandry upon a stable basis is only possible where, in addition to vigilant guarding of portals of entry, careful and continuous attention is paid to the best and most approved methods of soil hygiene. The ever constant temptation to overstock and overgraze winterless pastoral lands must be steadily resisted, and from the very beginning pasture resting and rotation should be practised to improve fertility and avoid concentrated disease infection. When the fence is built, and the paddock provided with a water trough, the investment in expensive breeding stock can be made, with reasonable assurance that the return in profit will extend over many years.

SOME NOTES ON SURRA IN THE CAMEL, ITS TREATMENT AND PREVENTION.

(*Continued from* p. 292, 1925.)

By Major V. C. LECKIE, D.S.O., M.R.C.V.S.,
Royal Army Veterinary Corps.

Some considerable practice is required for the proper introduction of the needle into the vein; bruising is likely to occur with a blunt needle in rough hands, moreover with a long needle it is possible to drive the cutting edges right through the vein. In either case swellings and sloughings are likely to be induced, due to the tartar emetic solution escaping outside the jugular vein.

The most satisfactory needle has been found to be the "intravenous injection" needle used in human practice. It is cut down to a little more than two-thirds of its original length, a good cutting edge is put on, a sharp point being unnecessary, provided that the cutting edges are always kept sharp, and for which purpose an oil stone should be used. Such shortened needles as described above have been in constant use for two years without breaking or bending.

For sterilising the needle between injections a small beaker of

methyl alcohol is needed, into which the needle is dropped after each injection and a stilette passed through the lumen. It is advisable to tie a silk thread round the base of the india-rubber tube in close proximity to the needle to prevent leakage, as the india-rubber tubing is liable to become stretched with constant use. Although less economic, it is more convenient to cut off a small piece of tubing from time to time, as it becomes stretched, for one frequently wishes to remove the needle from the tube for sterilising, sharpening, etc., and when tied this takes more time and necessitates refastening.

THE OBSERVATION OF THE CAMEL WHILST UNDER TREATMENT.

In the early stages of treatment the camel appears to have two separate adverse influences to contend with, viz.: (i) the harmful effect of the disease on his system due to surra toxæmia, (ii) the injurious effect of the drug employed, i.e. potassium antimony tartrate poisoning.

As the first of these improves, the drug seems to be better tolerated, and therein lies the necessity of a very gradual increase in dosage until the drug is well tolerated. The ideal treatment is the administration of a sufficient quantity of tartar emetic to keep the disease under control without injuring the system, till the animal is strong enough to tolerate the drug, when larger doses may be given and the system saturated to ensure a cure.

A great percentage of camels will certainly become " sick " during the course of treatment. It is therefore most important to note the first signs of indisposition, so that dosage may be decreased or stopped altogether till there is improvement in health. If the treatment be pushed to any extent when the camel becomes sick, death most certainly will be the result. Before proceeding to enumerate those symptoms presented during treatment, which may be considered as adverse, and those signs which are favourable, some notes on the action of tartar emetic in the body may not be out of place.

THE ACTION OF POTASSIUM ANTIMONY TARTRATE IN THE BODY.

For the better understanding of the action and toxic effects of the preparation of antimony one conveniently may quote extracts from *Veterinary Medicines*, by Finlay Dunn, tenth edition, which for the purpose of these notes are concisely recorded :—

" The salts and preparations of Antimony in their physiological as well as their chemical relations resemble those of Arsenic and Bismuth. They combine with albumin, are precipitated by acid solutions, and consequently exert their irritant effect where they meet acid secretions, as in the stomach and around the orifices of the sweat glands. With the exception of the chloride, which is a powerful escharotic, Antimony Salts, locally applied, produce in-

flammation of isolated spots, causing first papules and subsequently pustules. The solubility of the several preparations mainly determines their activity.

"In animals that vomit they cause emesis, cardiac and muscular depression, and increased secretions. Large doses produce gastro-enteritis and paresis of the spinal cord. Given for a considerable period, they induce fatty degeneration. . . .

"Reflexly, from the stomach, as well as by acting on the heart and vessels, it produces in men and carnivora cardiac and vascular depression with lowered blood pressure. It slightly increases but subsequently diminishes the number of the respirations, reduces temperature, relaxes voluntary and involuntary muscles, and increases secretions from the skin, bronchial and gastro-intestinal membranes. Poisonous doses cause purging and gastroenteritis, and when their action is very violent, after slightly exciting, they paralyse both the motor and sensory tracts of the spinal cord.

"In many of its actions it resembles Phosphorus and Arsenic, notably in arresting the formation of glycogen and in causing fatty degeneration of the liver and other organs. It is eliminated in the mucus of the stomach and bowels, and also in the bile and urine. It increases the excretion of urea. As with arsenic, animals receiving small doses acquire a condition of tolerance and with impunity take doses which would otherwise prove dangerous."

The knowledge of the general action, medicinal properties, and toxic effect of the salts of antimony is most important when undertaking the treatment of surra. The general actions above quoted bear relatively on the adverse symptoms induced. The camel tells you plainly when he has "had enough" and requires rest from treatment, but it requires experience to understand him; further, when he is noticed to be "sick," his system, as far as possible, must be cleared of the drug in order to arrest further harmful effects from the amount of the drug still remaining in his system. This is done by administering magnesium sulphate in good big doses (from 2 to 4 lb.) dissolved in several gallons of water. This may have to be repeated twice or thrice, till the camel is thoroughly purged, and if the harmful effects of the drug have not gone too far he will return to a normal state of health in a few days, otherwise he may remain ill for as long as two months.

During the period of "sickness" he should be fed on a laxative diet—young green wheat, turnips, shaftal, burseem, taramira, etc.—and for this purpose there is a very valuable salty herb known as "lana," which grows fairly generally most of the year round in the Punjab. If the latter is procurable the bowels may be kept continually lax.

UNFAVOURABLE SYMPTOMS DISPLAYED DURING TREATMENT.

The first indication of indisposition on the part of the camel appears to be a rise in body temperature, and experience has shown that it is not advisable to give an injection to any camel registering a body temperature of 100° or over. The camel's temperature is said to range from 97° to 101° during the twenty-four hours of the day, but the mean in health would appear to be 98°. It is therefore necessary to take and record the body temperatures of all camels that are to receive an injection. A rise in temperature during treatment is generally followed by a train of adverse symptoms, viz.: (*a*) cessation of rumination; (*b*) going "off feed;" (*c*) orange-coloured

FIG. 3.—TYPICAL CASES OF SURRA ARRIVING FOR TREATMENT.
Camel No. 162 on the left of the photograph received 32½ grammes sodium antimony tartrate, and had gained 100 lb. on the termination of the treatment.
Camel No. D.-30 on the right of the photograph received 49 grammes sodium antimony tartrate, and gained 200 lb. in weight on the termination of the treatment.

or blood-tinged urine; (*d*) congestion of visible mucous membranes, which eventually may become yellow or orange stained; (*e*) watering of the eyes and nose, occasionally with ulceration of the mucous membrane of the nasal cavity; (*f*) a more or less generalised dermatitis (more particularly in hot weather, when the animal perspires freely and is therefore distinguishable from camel mange, which is not seen much in very hot weather); (*g*) constipation; (*h*) paraplegia and muscle tremors; (*i*) hæmorrhages and disorganisation of the internal eye.

These appear to be attributable entirely to the action of the drug employed. For instance, the yellow staining of the visible mucous membranes, particularly noticeable in the eye, probably is due to the action of the antimony salt on the liver, giving rise to a fatty degeneration, so that the liver does not function properly, and bile, that normally should be picked out of the blood stream and eliminated in the intestinal track, remains free in the circulation to stain tissues

and organs generally. Except in the case of very debilitated camels, this often takes place after the administration of about the 10th or 12th gramme of tartar emetic. Again, the deficiency of bile in the intestinal tract may account for the constant constipation that has to be dealt with during treatment.

When camels suffering from tartar emetic poisoning are purged by magnesium sulphate, the liquid fæces, being to some extent saturated with the antimony salt, excoriate the thighs below the anus to as far as the hocks, showing that the drug is being eliminated in this way.

On the appearance of any of the adverse signs enumerated above, the camel must be rested from treatment at once, for he is suffering from tartar emetic poisoning. The salts of antimony being eliminated in the fæcal mucus, urine, and body sweat, the beneficial effects of purgation and laxative diet may be readily understood.

Observation, therefore, is a very important factor in successful treatment, and it is the custom at the Lahore camel hospital to do this by stages, so that a good portion of the morning is occupied in this way, before the actual injection takes place. The camels are first fed to observe the manner in which they eat, i.e. ravenously, slowly, every now and then, or not at all. This is easily done by standing at the end of a line of camels feeding, the heads of those " off feed " remain up and quite still, while the remainder have their heads in the trough. The fæces are next observed, the constipated or semi-constipated are then noted. Examination of the fæces gives the degree of constipation or otherwise in a given camel. The separate stools of fæces are normally large, soft, moist with mucus, of a greenish colour, varying a good deal with the diet, each integral portion resembling, for purposes of description, a sphere that has been flattened. It is voided in masses, the individual stools for the most part adhering together. When constipation has set in, the separate fæcal elements are dark in colour, hard, ovoid and elongated, having a distinct conical apex at one end. In the more advanced stages of constipation the fæces voided resemble that of the sheep or goat.

The temperatures of all to be injected are then taken and recorded, and an examination made of the eyes, a search being made for opacities, corneal ulcers, hæmorrhages, and yellow staining of the schlerotic, conjunctiva, or membrana nictitans. This done, the camels are taken to the water trough to drink, and an observation is made of their urine. The camel micturates almost immediately on being taken to water, and as the operation lasts from eight to fifteen minutes, the observation of urine is not difficult. It may be noted here that camels that have browsed on " pipal," one of the Indian fig-trees,

pass urine the colour of red ink, so that urine observation in their case is impossible.

The Favourable Signs to be looked for in Camels under Treatment.

The camel that is doing well under treatment may be briefly described as having a bright and almost alert appearance. He feeds well, his coat is sleek, his periods of rumination frequent, and he rapidly puts on condition; his body temperature registers 98° to 99°; he may come into "musth" and have a tendency to quarrel with his fellows, but although this latter is an indication that the animal is feeling "fit," he will not put on condition as rapidly as when not in "musth." The fæces are soft in consistence and the separate stools large, the urine pale, clear, and passed in good quantity.

The Dosage.

It will be seen from the foregoing remarks, that no definite standard of dose may be laid down as a safe treatment for a given camel, and that it is only by carefully watching individuals that the mortality in the treated is kept down to a minimum.

It would be a tedious proceeding to enumerate series of successful and unsuccessful treatments, therefore a general standard is given, from which 95 per cent. of cured cases was obtained. That is to say, twenty camels were put as far as possible (having regard to individual requirements) on this standard treatment as a test. Of these, nineteen passed through the course of treatment, improved in health and condition, and remained negative for a period till their discharge from hospital. Further, 1 c.c. of blood taken from a control camel of this series was injected hypodermically into a healthy guinea-pig, fourteen days after the termination of the treatment, and the blood of this guinea-pig examined for thirty-three days remained negative to trypanosomes.

However, it may be noted that about 35 per cent. of these camels became "sick" on varying dates from the commencement of treatment, generally between the administration of the 12th and 18th grammes of tartar emetic. These had to be taken off treatment for periods of time ranging from eight to fourteen days, and when put to treatment again were started with a small dose, i.e. 50 c.c. of a 1 per cent. solution. Subsequent to these periods of sickness the camel appears to tolerate the drug well, and after the 20th or 22nd gramme, the disease appears to be well under control. Better health is maintained, and the system may be confidently saturated, i.e. larger doses may be given.

TABLE II.

STANDARD OF TREATMENT EMPLOYED FOR TWENTY SURRA-POSITIVE CAMELS AS A TEST. THIS STANDARD WAS ADHERED TO AS FAR AS POSSIBLE, HAVING REGARD TO SYMPTOMS DISPLAYED BY INDIVIDUAL CAMELS. THIS TEST GAVE 95 PER CENT. CURED.

Injection Days.	Dose Employed.	Remarks.
1st day	20 c.c. ½ % solution tartar emetic	½ a gramme tartar emetic in three consecutive days.
2nd day	20 c.c. 1 % ,,	
3rd day	20 c.c. 1 % ,,	
5th day	50 c.c. 1 % ,,	1½ grammes in six days.
7th day	50 c.c. 1 % ,,	
9th day	50 c.c. 1 % ,,	
11th day	100 c.c. 1 % ,,	3 grammes in six days.
13th day	100 c.c. 1 % ,,	
15th day	100 c.c. 1 % ,,	
17th day	150 c.c. 1 % ,,	15 grammes in twenty days. During this period sickness from antimony poisoning is likely to occur, and treatment is stopped as soon as the first adverse signs are noticed. On starting treatment again a small initial dose is given. The drug should now be well tolerated.
19th day	150 c.c. 1 % ,,	
21st day	150 c.c. 1 % ,,	
23rd day	150 c.c. 1 % ,,	
25th day	150 c.c. 1 % ,,	
27th day	150 c.c. 1 % ,,	
29th day	150 c.c. 1 % ,,	
31st day	150 c.c. 1 % ,,	
33rd day	150 c.c. 1 % ,,	
35th day	150 c.c. 1 % ,,	
37th day	175 c.c. 1 % ,,	3½ grammes in five days.
39th day	175 c.c. 1 % ,,	
41st day	175 c.c. 1 % ,,	
43rd day	200 c.c. 1 % ,,	8 grammes in seven days. The system may now be saturated.
45th day	200 c.c. 1 % ,,	
47th day	200 c.c. 1 % ,,	
49th day	200 c.c. 1 % ,,	

Total of 33·25 grammes tartar emetic in seven weeks.

It has been the custom at Lahore, if there has been a long period of sickness during treatment, to give rather a larger quantity of tartar emetic than laid down by Captain Cross (viz. 28 to 30 grammes), and some of our camels have received as much as 38 and 40 grammes, without any apparent ill effect. It is interesting to note that camels that have been through a course of treatment, and become again re-infected in their villages, may with safety be given very much larger doses throughout the course of treatment, having acquired a toleration to the drug during their first treatment.

(To be continued.)

Clinical Articles

A CASE OF CASTRATION IN AN INDIAN SLOTH BEAR (*MELURSUS URSINUS*).

By D. S. LAUD, G.B.V.C.,

Veterinary Officer and Assistant Superintendent, Zoological Collection, Victoria Gardens, Bombay.

On April 25, 1925, the Indian sloth bear located in the cage in the park was found to be suffering from orchitis, with a wound ¼ inch in length on the left scrotum, the result of a fight with others in the same cage.

The animal was removed to a smaller cage in the infirmary in the gardens, wherein it could be secured for treatment.

Treatment.—A cooling astringent wash was prescribed, consisting of :—

℞	Alum. Exiccat.	℥ii.
	Zinci. Sulph.	℥iv.
	Plumbi Acetas.	℥iv.
	Aqua	Oi.
	M. ft. lotio.	

This was applied with a syringe from the outside of the bars of the cage.

Internally, Pot. iodi grs. vi. in drinking water. Usual diet, viz. bread soaked in milk, was given, and when the bear appeared to be fastidious and refused even milk, Limji biscuits (country biscuits) were given, which were eaten readily. On April 30, 1925, the swelling had disappeared considerably. Pot. iodi discontinued. On May 7, 1925, the left testis had protruded from the scrotal wound, due to the animal having scratched and opened it with its nails. An unsuccessful attempt was made to return the protruded testis into the scrotal cavity and to put on ligatures. Considerable difficulty was experienced in securing the bear to one side of the cage with thick cotton ropes, and it took nearly an hour, as the animal was a full-sized, well-developed beast. It was therefore decided to perform unilateral castration of the left testicle. No castration instruments were at hand, but as the animal was already secured I did not like to defer the operation.

Technique Observed.—The parts were washed with Sol. of carbolic acid and a ligature was put round the cord. The testis was then removed with a knife just below the ligature. There was no hæmor-

rhage, and the wound was dressed and plugged with Tinct. iodi. Subsequent treatment consisted in syringing and washing the part from outside the cage with Lotio iodi 1 in 40. The wound healed up nicely, and the bear was discharged on May 19, 1925.

RUPTURE OF FLEXOR TENDONS IN HORSES.

By DONALD CAMPBELL, M.R.C.V.S.,
Rutherglen.

THE two cases of rupture, or rather detachment, of the flexor pedis perforans tendon that I am going to describe occurred in two pit ponies on the same day and in the same pit, though in different sections of the pit. The day was the 23rd of July, 1923, the day on which the colliery resumed work after being closed down for ten days' holiday. During the holidays the ponies were underground, each in a stable with between twenty and thirty others, fed with chop and watered in a trough at the end of the stable twice a day.

When work was started, number one pony went suddenly lame on the near hind leg while drawing his first load, and was brought back to the stable. Only the heels of the foot touched the ground, the toe being turned up about 1½ inches, and the fetlock sunken, but quite clear of the ground. He was standing when I saw him, distressed, excited, and breathing very rapidly, fidgeting incessantly on his hind feet. Weight-bearing on the off-hind foot seemed to be every bit as painful as on the near-hind, though there was no evidence of any rupture there : probably one was imminent.

The other pony had over a mile to travel, most of the way up a very steep incline, before reaching that part of the mine where his work lay. After walking nearly a mile, with no hutches attached, he ruptured the deep flexors of one hind leg, showing the usual symptoms. The driver travelled him on, and very soon afterwards the flexor tendons of the other hind leg gave way and the pony went down. Before I saw him he had been raised and moved into a branch road, where he was standing when I arrived. His symptoms were just an aggravated copy of those that the first pony exhibited.

Both ponies were destroyed. In each of the three affected limbs the flexor aponeurosis was torn away from the semilunar crest of the coffin bone, with many small fragments of bone adhering to its lacerated stump. I should have liked to see the off-hind leg of the first pony, that is, the leg wherein pain was very manifest without any sign of rupture, but by mistake it was not sent.

What chiefly prompted me to write this note was that on the corresponding day of the previous year, the day when work was resumed after the summer holidays, five ponies in this mine suffered the same mishap. So the mine manager informed me. I have been told that such an occurrence is not uncommon among pit horses, but if so, I have not seen the cases recorded.

The circumstances surrounding these cases which I have noted indicate that some common cause must have been in operation. To doubt that would be imposing too great a strain on coincidence. Broadly speaking, the causes of rupture of tendons as stated by the authorities are over-exertion, debilitating diseases, local infections, faults in nutrition, and prolonged rest. Of these the first three and the last may be ruled out as inapplicable in my cases. Rest there was, but not prolonged rest; following the rest was exertion, but not over-exertion. There remains as a possible cause faulty nutrition. I believe the feeding, watering, and general attention were ample and appropriate, but nutrition does not begin and end with the bucket and the manger. These ponies each stood for ten days in a stable full of horses, which normally is empty for eight hours per day, therefore, unless additional ventilation were provided, there would be a decrease in the oxygen content of the stable atmosphere and an accumulation of carbon dioxide; the temperature also would rise and the air contain more moisture than usual. Glaister and Logan say, in *Gas Poisoning in Mining and Other Industries*, "Cool air and air movement promote the metabolism and activity of the body, and by stimulating the cutaneous nerves keep up the tone of the body. The cutaneous sense-organs are influenced by the temperature and by the relative humidity of the air which controls the evaporation of moisture from the skin. Impure gases in a mine have a much more serious action when the temperature is high or where there is not sufficient movement of the air to keep it cool." It is pretty widely known that in many mines during stoppages of work the ventilating fans are slowed down with the object of saving electricity—though I have never heard a manager admit that the practice was followed in his mine. One may be sure, at any rate, that no additional ventilation was allowed. I do not mean that carbon dioxide was excessive or oxygen deficient to an extent that would be noticed, but that the combination of a slight excess of the one and lack of the other with unusual warmth and humidity of the atmosphere over a period of ten days might so affect metabolism as to cause some deterioration of body tissue which manifested itself in rupture of tendons when strain was imposed on them

SOME CLINICALS.

By HERBERT C. ROCKETT, M.R.C.V.S.,
Salisbury.

1. I was asked to see a grey pony, about ten years old, supposed to have colic and to be unable to swallow.

When I arrived, I found the pony quite quiet, but he soon showed slight signs of choking, and about two-thirds down the neck on the near side there was (or I imagined there was) a slight swelling. When made to move over the pony was a little unsteady on his hind legs.

The probang was passed without any difficulty, but almost at once the pony became distressed, the respiration being shallow and sighing, and the temperature when taken was found to be 96·4.

A definite diagnosis was not asked for, therefore not given, and I gave instructions that 2-oz. doses ol. lini were to be given as a lubricant every couple of hours and I was to be sent for if matters became worse.

They did, and when the man attempted to give the first dose of oil, the pony fell over.

When I arrived again the respirations were much worse and temperature 95°, and I quite decided the subject would die.

However, by way of doing something I gave strych. gr. i. (hypod.) and left the pony for the night, telling the man first to keep it comfortable with plenty of bedding and to see the rug kept on.

In the morning I was surprised to find the pony much better, though there was still some difficulty in swallowing, and the gait was a little unsteady; also the bowels had not acted at all.

I gave a full dose of aloes, very carefully, left a few tonic powders, and ordered sloppy mashes, etc.

I saw the pony a time or two afterwards, but he went right ahead, and never showed any more symptoms, either of choking or the unsteady gait.

I never diagnosed the case to my own satisfaction. The pony was out at grass at the time, and there was never anything abnormal with the urine.

2. I was called in to see a two-year-old bull whose left testicle and cord had rather suddenly become very much enlarged, though there was no acute pain.

The bull was not valuable and in good order, so I suggested that it would probably be the best thing to send him to the butcher. Perhaps a little hasty, but it seemed the wisest course, and the owner agreed.

I examined the testicle and cord afterwards, and in my opinion it was undoubtedly a case of actinomycosis, and a doctor neighbour

of mine thought the same, though I wished afterwards that I had had a section examined.

3. Sealyham terrier admitted to infirmary showing what appeared to be symptoms of acute rheumatism of muscles of neck and shoulders.

This case did not yield to treatment, and later the diagnosis was altered to dislocation of cervical vertebræ, but no very definite spot could be found.

The head could be depressed but not raised, without acute pain, and lateral movement also caused pain.

I was not able to reduce the dislocation, and as the dog gradually became worse and paralysis extended, he was destroyed after three weeks.

Post-mortem revealed the articular facet of the fourth vertebra on the left side displaced, and over that of the third, the right side was normal. The cord was appreciably flattened.

I learned later that the dog had been ratting among some bundles of brushwood, and probably got his head caught, and dislocated it in getting free.

4. I was asked to see a yearling foal that was down and unable to get up.

Having examined it I could make out nothing definite, so raised it with slings, and could still find nothing except that it seemed that the colon was very impacted.

I treated this, but with no success, and as there was no improvement the owner decided to destroy the foal, which was sent to the kennels.

I was not able to see the post-mortem, but the owner informed me a few days ago that in the small bowel a circular piece of slate was found, so wedged as to make a complete obstruction. He said he had kept the piece in his office for a long time to show me, but had then managed to lose it. I don't know if that was all the trouble, but it was all I could hear of.

5. Five-year-old cocker spaniel admitted to infirmary April 24th, for board only, until her owner could find a house. She was taken out by owner every day and seemed perfectly well and happy in every way, but had a habit of soiling her bed badly. This was remarked on, but her owner said she had done that since she had been in quarantine for six months fairly recently.

Nothing was noticed wrong until May 29th, when her owner remarked to my man when he brought her back that she had seemed a little tired, so he had not kept her out as long as usual, but he had not noticed anything definite. On the 30th he took her out again, but not for long for the same reason; however, she trotted up to her

kennel quite happily, but a quarter of an hour later when my man went up to see another dog she was dead.

On examination I felt some large calculi in the bladder, and on opening her found six, weighing 1¼ oz., and almost completely filling the bladder. The calculi were quite smooth and faceted.

No doubt these could have been detected months ago, but there was no reason to examine her except for her habit of soiling her bed, and as she seemed in such good health I did not attach the importance I ought to that, especially as her owner had her out every day, and frequently said how well and happy she seemed. She never left any food the whole time she was here.

CLEFT PALATE WITH LIPOMA OF THE EUSTACHIAN TUBE IN A BULLOCK.

By TOM HARE, M.B., Ch.B., B.V.Sc., M.R.C.V.S.,
The University of Liverpool.

Subject.—A shorthorn bullock aged about thirty months.

Slaughtered for food at public abattoir.

The meat inspector, when forwarding the specimen, stated that the carcase was "lean and scraggy, but showed no evidence of disease."

Examination of the upper jaw revealed a cleft palate, together with a movable pedunculated tumour occupying the cleft, but not obliterating the communication between the nasal chamber and the pharynx.

The Cleft Palate.—The single median fissure involved the whole depth both of the soft palate and the horizontal plate of the palatine bones, the latter having failed through some developmental defect to unite in the median palatine suture. Superficially the apex of the cleft was on a line bisecting the third molar teeth.

As will be seen from the attached photograph the healthy uninjured mucous membranes and subcutaneous tissues of the hard palate and nasal chambers were in direct continuity over the edges of the cleft.

The following superficial measurements were recorded :—

Apex of cleft to anterior edge of dental pad = 22·5 cms.

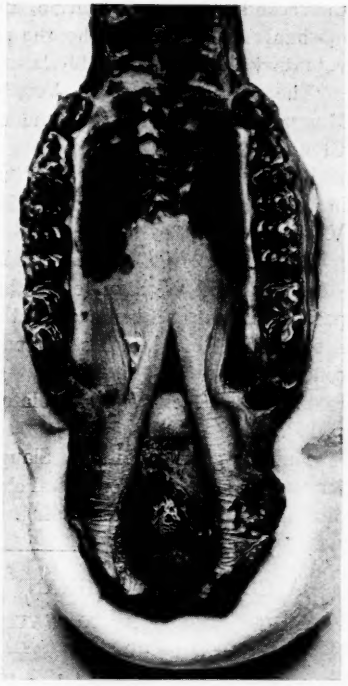
Apex of cleft backwards to hamulus of pterygoid bone = 7·5 cms.

Greatest width of cleft = 4·0 cms.

No other abnormalities were present.

The Tumour was a polypoid growth having the shape of a flattened pear, with slightly wrinkled surface, and of soft consistency. Total weight = 170 grammes.

Its inferior edge occupied the cleft in the palate, its anterior rounded and swollen extremity presented into the posterior nares, while its superior edge was applied to the roof of the pharynx. Its short pedicle occupied the right Eustachian tube, and was traced to its origin in the loose connective tissue internal to the muscular process of, and just below the external opening of the osseus canal in, the petrous temporal bone. The greatest diameter of the pedicle within the tube = 1·2 cms. The right Eustachian tube was deformed into a trumpet-shaped recess presenting a gaping pharyngeal opening.



The cut surface of the growth was opaque, white and greasy.

Microscopically the growth consisted of a central mass of ordinary adipose tissue, containing a relatively meagre amount of stroma radiating from a peripheral layer of fibrous tissue. The surface of the tumour was lined by a single layer of columnar epithelial cells, beneath which were numerous mucous glands and lymphoid follicles ; i.e. the structures forming the lining membrane of the normal Eustachian tube.

No inflammatory or malignant changes were evident.

Discussion.—The defect in the palate is of the " incomplete " in contradistinction to the " complete " variety, in which the cleft involves the entire hard palate and premaxillæ.

The origin of the lipoma may be traced to the loose connective tissue covering the base of the cranium. The resistant bony and muscular tissue at its seat of origin would require its slow progressive development following the line of least resistance towards the pharynx. Consequently, the yielding tissues of the Eustachian tube in response to the outward thrust would undergo a hyperplasia of all its elements to form an envelope, which in turn became consolidated in the tissue mass of the tumour. Once the lipoma became a definite entity

within the Eustachian tube, it is possible that the constant stimulus of deglutition may have contributed to the extent and direction of its growth.

In the absence of clinical evidence it is deemed undesirable to point to more than one of the many interesting physiological speculations provided by the findings. It appears reasonable to suggest that in order to secure the animal's survival some mechanism must have operated to reduce the cleft, partially or, completely, during the second stage of deglutition, and further, that this compensatory mechanism was supplied by the pharyngeal muscles, originally as a voluntary effort, and possibly later as a pure reflex.

The Specimen is in the Veterinary Section of the Pathological Museum of the University, under the direction of Professor Ernest Glynn.

Two very interesting cases of the incomplete variety of cleft palate in the horse are described by Messrs. Ridley and Hobday in the VETERINARY JOURNAL.

1. "A Case of Cleft Palate in a Foal," 1911, Vol. 18, p. 740.

A thoroughbred filly five months old. Since birth milk observed to pass down nostrils when sucking the mare. Fluids still escape via the nostril. Cleft of 1½ inches confined to soft palate. Filly not in bad condition.

2. "An Interesting Cleft Palate in an Aged Horse," 1912, Vol. 19, p. 160.

Mare in good condition. Slaughtered at age of twenty-two years for severe lameness. Congenital cleft of soft palate. Always had nasal discharge during and after feeding.

A CASE OF MALIGNANT CATARRH IN A HEIFER.

By W. WATERS, M.R.C.V.S.,
Halstead.

Subject.—A pedigree red poll heifer about twenty months old, purchased ten days previously at a society sale.

History.—At 6 p.m. on April 15, 1925, I received an urgent message to attend this heifer as it was thought she was aborting her calf. On arrival the heifer was lying down and refused to get up. She was in a semi-comatose condition with her head turned to her side, similar to milk fever. Every few minutes she strained violently, but passed no evacuation either rectal or vaginal. Temperature 105° F. On inquiry, stockman informed me she was apparently normal when turned out to grass at 9.30 a.m. that morning, but when he went to get her in about 4 p.m. had greatest of difficulty in doing so.

Diagnosis.—Was unable to diagnose the case in first instance, but suspected poisoning, more especially as had attended a previous case of lead poisoning three months before.

Treatment.—As no dung was being passed in spite of her straining, I gave her 1½ pints of ol. lini, followed by 2 oz. mag. sulph. in gruel every four hours, in case it should prove to be lead poisoning.

April 16th, 7 a.m.—Found heifer had now stopped straining, was slightly brighter, and able to get up with persuasion. Temperature 103° F. Bowels much relaxed and fæces very offensive.

Later, 7 p.m. same date.—Case now presented the following symptoms: In standing position, and rose on all four feet without signs of vesication. Dribbling of saliva from mouth and marked smacking of lips every few minutes, whilst examination of mouth revealed ulceration at base of tongue. Temperature 103° F., purgation very severe, and animal very prostrated.

Having had no practical experience with foot-and-mouth disease, and not wishing to take the responsibility of holding the case over for further developments, I now reported the case as suspected foot-and-mouth disease, and applied the five-mile restriction of movement order. I prescribed chlorodyne in gruel every three hours to allay the purgation.

Friday, April 17th.—My next visit was paid in company with the Board of Agriculture Inspector. There was now an increased salivation, but no localised vesication in mouth; in fact nearly all mucous membrane of mouth was now in process of being sloughed. There was also marked congestion of nasal mucous membrane, associated with copious catarrh from nostrils. Diarrhœa still very persistent and offensive. Feet still tender, with no signs of vesication. The Board of Agriculture Inspector decided that it was not foot-and-mouth disease, although certainly suspicious, and it was decided to retain the restrictions for another twenty-four hours. We were unable to decide if it were a case of catarrhal stomatitis or malignant catarrh. If the former, we could see no reason for nasal lesions; and if the latter, should have expected discharge from eyes as well. An electuary consisting of alum, borax, and treacle was now prescribed, in addition to chlorodyne in gruel as before.

To sum up the case, animal sloughed most of mucous membrane of tongue, lips, and dental pad, after which she gradually improved, beginning to eat grass about fifth day and chew her cud on seventh day, eventually making a perfect recovery. About the fifth day she showed symptoms of conjunctivitis, although had no discharge from eyes, so concluded that it was probably a case of malignant catarrh and not stomatitis.

THE REPLACEMENT OF THE EVERTED BOVINE UTERUS.

By L. W. WYNN LLOYD, F.R.C.V.S.,
Carnarvon.

At a recent meeting of a Division of the N.V.M.A., one speaker described the operation of amputation of the uterus. He went on to say, " Previous to this I had always destroyed the cow when unable to return the womb."

To me this confession caused some surprise, for I am afraid that I have the misfortune to serve a very exacting *clientèlle*, and failure to deliver a calf or to return an everted uterus would certainly damage one's reputation considerably. I confess that with very many of these cases I expended more time and energy and risk of impaired health than the life of the animal justified.

I do not suggest, of course, that every everted uterus should be replaced. One meets with traumatic and other conditions where amputation offers the only hope of saving the animal's life.

Probably no accident occurring as a sequence to parturition in the cow has received less attention as to its scientific treatment as the everted uterus, though it ranks among the common accidents of the puerperium. Little or no progress has been made during the past century. The technique described in the works of empirics of a hundred years ago is practically the accepted technique of to-day, and, apparently, little advantage has been taken of the discoveries of Lister, though in this connection they have a particular application. Eversion of the uterus is a condition which is commonly handled by the layman—the ubiquitous " handy man." This is partly owing to the owner's idea of saving expense, and partly because of panic on the part of those who have the care of the animal, and the prevailing notion that the delay entailed in sending for professional assistance may be prejudicial to the life of the patient. Add to this the common opinion that a cowman can " push it back " as effectively as a veterinarian.

In view of all these facts, it behoves the practitioner to adopt methods, in handling these cases, which are scientific and practical; and to show, by his deportment, his superiority over the empiric, and above all to ensure a high percentage of recoveries.

The writer, some years ago, conscious of the unsatisfactory features of the accepted technique, amended his methods of handling these cases. The result has been an immense saving in physical exertion to the obstetrician, less suffering to the patient, a reduction in the mortality of about 20 per cent., and incidentally an appreciation of the superiority of the services of the graduate over those of the empiric.

The technique may be considered under the following heads:—

(1) The clothing of the operator.
(2) Anæsthesia.
(3) Position of the patient.
(4) Preparation and handling of the hernia.
(5) Reposition.
(6) After-care of the patient.

(1) The operator should have no covering which will interfere with the performance of this arduous work, and this covering must be waterproof and be capable of disinfection after each case. This he owes to his patient. At the same time he should be adequately protected against the risk of chills whilst doing this work, often in cold and draughty byres. This he owes to himself.

The writer's obstetric kit includes a sleeveless under-shirt which he wears next the skin, over this a sleeveless smock with tape " purse-strings " at the neck and arm-pits, and trouser overalls. The suit is made of material similar to strong calico and rendered waterproof. It tolerates immersion in hot water and is easily disinfected. It is light and pliable and does not in the least hamper the obstetrist during his manipulations.

(2) Owing to the position in which the patient is placed (with the hind quarters slung up), the writer has not deemed it wise to resort to the administration of chloroform. The abdominal viscera are forced forward and press on the diaphragm. This pressure may so interfere with respiration and the heart's action as to render chloroform anæsthesia inadvisable. Again, the operation, which may turn out to be a protracted one, is such that the practitioner, once he has commenced reposition, must not be interrupted to attend to any untoward incident. Morphia has been tried, but was found to be unreliable, partly because of the excitement it sometimes causes and partly owing to the tendency to constipate, and hence cause the animal to strain a day or so later.

Chloral hydrate is the agent of choice in these cases. Though not conforming strictly with the description of anæsthetic, it attains the object. From 1 to 2 ounces, dissolved in 1 quart of cold water, is given *per orem* as soon as the surgeon arrives on the scene.

(3) Position of the patient. This, we insist, is the most important consideration in the whole procedure. The cow, we have noted, is down on our arrival in the majority of cases. If she is standing, she will usually go down under the influence of the hypnotic, but if she refuses she is put down gently by Rueff's method. An assistant applies a small hempen hobble above each hock. The hobbles are each 18 inches long and have a loop at each end. One loop is pulled

through the other. The obstetric pulley is fixed, one hook to a rope round a beam above and the other to the free loop of each hobble, and the animal hauled up by the hind limbs so that the sacrum is about 2½ feet above the ground. One then places a sack, filled tightly with straw, crosswise under the loins. The hind quarters are now slightly lowered so that the weight is borne partly by the sack and partly by the pulley. The method, of which this is a modification, is mentioned, but not advocated, by Fleming, and suggested as a possible expedient by W. L. Williams. The procedure apparently seemed too revolutionary and drastic to be recommended by authors as practicable. Indeed, this was the view always held by the present writer until he encountered what he thought would be his "Waterloo," in which the operator was thoroughly exhausted, and all other means having failed, he was driven to attempt this one. He has since adopted the method in a series of over one hundred cases, with most gratifying results. Its advantages are apparent. The cow is thoroughly secured, no one is required to steady her beyond one man at her head; the advantages of gravitation are immense; the uterus, when supported and manipulated, becomes appreciably smaller by allowing the return flow of the blood it contained; the bladder and any bowel which may have followed the hernia fall back; the tail is out of the way; the anus is below and there is none of that annoying soiling of the uterus by fæces during replacement; the position is convenient to the operator and not calculated to cause cramp; it aids the proper disposition of every part of the uterus after its return, and lastly affords an ideal position for amputation should this be eventually decided upon.

(4) Up to this point the work has been done by the attendant, under the direction of the operator. The latter has spent the interval in preparing his hands and arms and changing his clothing. He has so far conserved his energy for the strenuous work which awaits him.

To support the prolapse a clean sheet rinsed in an antiseptic solution answers the purpose fairly well, but is inclined to get into one's way as one proceeds. A great improvement is a tray constructed after the fashion of that used by butchers' errand boys to carry meat on their shoulders. It is considerably shorter and has no raised edge on the side nearest the vulva.

The antiseptic which we favour is carbolic acid, because of its reliability and its anæsthetic properties, and we use it in the form of glycerin-carbol to ensure its solubility. It is carried in a graduated bottle, so that the attendant makes no error as to the amount poured into a given quantity of water. The buttocks and perineum are washed and dried. Clean water at about body heat and clean pails

are insisted upon, and the cleansing of the uterus is commenced. The organ is turned from side to side, and raised to make certain that all blood clots and foreign matter are removed. A little solution is poured on by the attendant, with a clean jug, during actual reposition, with the object of removing any debris which may have been overlooked in the crevices.

One American writer asserts that this cleansing should be deferred until replacement is complete, and that it is then easier and more effectively performed. This is opposed to all physical laws and to reason.

The replacement should begin at the vaginal portion. The alternative method mentioned by Fleming and Williams of commencing by pressure with the closed fist on the fundus or everted horn is surely wrong in theory and both dangerous and difficult in practice. It causes a double inflection of the uterine walls, which thus take up more space in their passage through the pelvis. Again, by commencing at the cornu, the pressure necessary may be such as to cause rupture of the viscus.

The uterine contractions are far less active towards the cervix, and thus offer less resistance to that part of the operation—the first—which is most difficult.

Replacement, then, should proceed by " kneading " the mass at the vulvar edge and by patient pressure with both hands alternately. Little resistance is offered by way of expulsive efforts until the uterus has been returned into the pelvis. It is here when the inflection is at the most active part of the walls that opposition is felt. The essayist continues the pressure with both hands as far as the lumen of the pelvic canal will permit. One arm is then withdrawn and the process completed with the other—simply " holding our ground " during expulsive efforts and pressing forward at the intervals.

The last part of the reposition we consider the most important of all. It requires the exercise of endless patience.

Care must be taken to leave no " kink " in the uterine wall, and when we have accomplished this the cow will strain no more.

The cavity is now swabbed with methylated spirit on a wad of gauze. Douching is not only unnecessary but undesirable. The patient is lowered slowly on to a bed, already prepared by raising and lengthening the stall with turf covered with straw, allowing ample slope from the gutter down to the manger. The animal is placed on her sternum with all limbs flexed in the position normally assumed when lying down. Her usual drink is offered, which she generally accepts, and then some good hay. This tends to divert her attention.

Having performed his ablutions and dressed, the writer insists on the cow getting up to her feet. This he considers important,

partly to allow the uterus to take its proper place in the abdominal cavity and to promote involution, and partly to avoid that " cramp " which so commonly follows restraint—especially under the influence of an anæsthetic or narcotic, and becomes more marked the longer the cow is allowed to lie—often terminating in death from decubitus.

Contrary to what one would have expected, this method of slinging does not in the least degree injure any part of the patient's limbs. Indeed, since the writer has adopted it, he has got the cow to her feet in every instance before leaving. He could not claim this when he resorted to the orthodox methods, owing probably to injury to the metatarsal nerves, brought about by prolonged recumbency in an unnatural or cramped posture. We agree with Williams when he says that any artificial means of retaining the uterus are unnecessary. Certainly the numerous and formidable pessaries described by authors should find no place in the outfit of the modern obstetrician. The presence of such instruments—more or less crude—rubbing and pressing against the delicate mucous membrane of the womb will inevitably set up an irritation which it should be our earnest endeavour to avoid. Sutures and clamps are, likewise, relics of the empiric which should be shunned by the modern veterinarian. Apart from the pain they occasion, they afford foci of infection in a very susceptible part of the body which we should desire to prevent. They are unsurgical and unnecessary.

It is, however, advisable, for the sake of the peace of mind of the owner, to make at least a pretence at security against a repetition of the prolapse. I usually carry a " pocket " mouth speculum of rustless steel which is used in making casual examinations of the mouth and to protect the hand when administering a bolus. It has a small ring at one end which carries a spliced cord. The whole thus acts as a combined speculum and twitch, and it is secured over the vulva after the fashion of Lund's truss, described by Fleming (Fig. 219). This can be kept clean and does not add to the animal's discomfort. It is removed the following day. Little or no further attention is called for. The cow is kept in her stall for five or six days. The advice of Williams, that the cow should take forced exercise and be forbidden to lie down, seems unreasonable. If the surgeon finds during the process of swabbing that involution is tardy and not vigorous, he should prescribe a few doses of extract of ergot and extract of nux vomica. It is a common practice to flush the uterus on the second or third day. This is to be strongly condemned as serving no useful purpose whatever but capable of infinite mischief. If the animal shows no deviation from normal health there should be no interference, especially with the uterus.

Review

Milk Secretion: The Study of the Physiology and Inheritance of Milk Yield and Butter-fat Percentage in Dairy Cattle. By JOHN W. GOWEN, Ph.D. Baltimore: Williams & Wilkins Company. London: Baillière, Tindall and Cox. Price 22s. 6d.

This book, which gives the results of statistical research on Milk Records and Butter-fat Tests in the Advanced Register of the American Holstein-Friesian Society, is one which should be in the hands of all those who have to do with the setting of standards of milk production either for Breed Societies or for the Show Ring, and of those who are engaged in breeding cattle for milk production. It is, however, rather difficult reading for those who are not versed in statistics, although the author gives in plain language the application of his results to practice throughout the book, and includes short summaries of results at the end of every chapter.

The application of the science of statistics to the practical problems of physiology and inheritance is, as shown by Dr. Gowen, full of promise for the solution of many problems which confront the breeder of milking cattle. He finds among other things that the milk yield of a bull's mother is only half as good a measure of the milk yield of the bull's daughters as the record of the dam is of her daughters. There are also many methods given for spotting a good sire for increasing milk yield or butter-fat percentage before it is too late and he has been sent to the butcher. He also deals with the question of whether a good milking cow can be told by its conformation, and shows that the latter is nothing like so good an indicator of the yearly yield of milk as even a short (seven-day) milking test (at the time of maximum yield). The 365-day test (daily weighings) he also finds gives a better indication of a cow's true capacity for milk production than does a seven-day test (weighings made for a week at the maximum yield), because the latter is more affected by the preparation the cow has received before the test.

As regards the mode of secretion of milk, he concludes that we must look to the solids-not-fat as the major cause of the variations in yield of milk, and to some extent as to the cause of variation in butter-fat yield.

He also shows that the milk yield and butter-fat production of a cow increases up to her eighth year, and then declines again. Tables are also given from which the yield at any age may be estimated from the yield at a known age, but the value of these and other similar tables which he gives for estimations of the yields of relations can hardly be of general application, as the conditions under which these Advanced Registry tests are made are exclusive ones. This in our opinion is the greatest criticism of the work, for while the general principles which he elucidates can be accepted without hesitation, we are not by any means convinced that these Advanced Registry Records are a fair sample of the Holstein-Friesian cows of America, in spite of the evidence which he gives to this effect. Even with the very best of feeding we doubt whether the average yield of all cows would be slightly over 1,600 gallons per year, which is the mean for all the cows he is dealing with. No mention is made of the effect of the period of service on the yield, and while the full effect of this is reduced by the conditions of the Advanced Registry test, we doubt whether it is a negligible quantity even in these circumstances.

In the concluding chapters he gives a good summary of the breeding experiments that have been made by crossing high and low producers in milk and in butter-fat, and finds that the first cross between these is intermediate in production, but slightly on the high side in yield of milk and on the low side in butter-fat percentage. An attempt is also made to reconcile the two schools of thought on inheritance—the Biometrical and the Mendelian—and as the characters in question (milk yield and butter-fat percentage) are taken as being multiple factor characters, he has an easy task.

For those who are interested in milk records or in the breeding of cattle for milk or butter-fat, Dr. Gowen's book is well worth study. J. H.

Correspondence

"EPISTAXIS IN HORSES."

To the Editor of the VETERINARY JOURNAL.

SIR,—

With reference to the article in the issue of the VETERINARY JOURNAL on above subject, I always considered the hæmorrhage in these cases came from the Schneiderian membrane. I may be out of date, but it will take a lot to convince me otherwise, having seen the definite patch of blood-clot where a plexus of small vessels have ruptured.

Hæmorrhage from the lungs is quite another matter.

I cannot follow the editorial note that epistaxis may be due to cardiac disturbance.

As to treatment, I never found anything to equal keeping the horse at slow work for some days and giving acid sulph. dil. ʒ i, ferri. sulph. exsiccata ʒ i in ½ pint of cold water and mixed with a little nice food, night and morning. This should be given for a fortnight. Of course, in these days adrenalin may be better, but I doubt it.

Stourbridge, *May* 29, 1925. JAMES BLAKEWAY.

Notices

THE SEITZ' GERMICIDE-(E.K.-) FILTER.

A NEW type of filtering apparatus for obtaining sterile fluids, the Seitz' Germicide-(E.K.-) filter, arrives as a boon to veterinary bacteriologists engaged in the investigation of the filter-passing viruses or ultra-microscopic microbes. The laboratory model of this apparatus consists of a metallic receiver into the base of which is fitted a thin asbestos disc of 3 mm. thickness, the whole constituting a filter-funnel, which is to be fitted by means of a rubber stopper into an ordinary filtration flask in which a vacuum can be made. A feature of the actual filter is the absence of india-rubber washers, by which leaks due to worn and faulty washers are eliminated. The asbestos discs after use can easily be replaced by new ones, thereby doing away with the time-consuming operation of regeneration of a filter candle. The entire apparatus lends itself, when so desired, to being autoclaved.

Different models of this apparatus are available for different uses, such as in connection with the domestic water-supply or in industrial concerns. Used in connection with the domestic water-supply it is recommended that the discs be replaced once a week, and in times of epidemics that they should be changed twice a week.